26-01-01

Starting System

GROUP 26

PART 26-01 *General Starting System Service*

The function of the starting system in the vehicle is to crank the engine at a high enough speed to permit it to start. Heavy cables, connectors, and switches are used in the starting system because of the large current required by the starter while it is cranking the engine. The amount of resistance in the starting circuit must be kept to an absolute minimum to provide maximum current for starter operation. Loose connections, corroded relay contacts, and partially broken cables will result in slower than normal cranking speeds, and may even prevent the starter from cranking the engine.

In cases of starting system trouble, the owner may have discharged the battery before calling for assistance. At the time the trouble occurs, the owner is more interested in getting the engine started than in knowing the cause of the trouble. A road service procedure is presented to aid the service technician in such cases of starting trouble. Once the engine is started, be sure to follow diagnosis procedures in order to locate the cause of the starting difficulty. The road service is not a part of the diagnosis procedures. Refer to starting system diagnosis in the Diagnosis Manual.

PART 26-02 *Autolite Positive Engagement Starters*

A page number indicates that the item is for the vehicles listed at the head of the column.

1 DESCRIPTION AND OPERATION

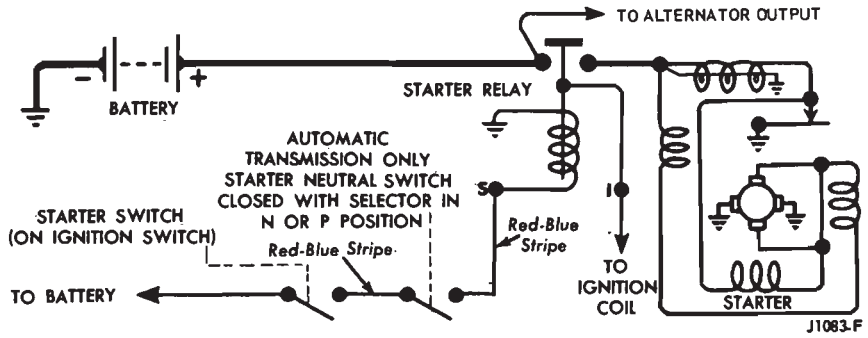

FIG. 1—Starting Circuit

The starting system includes the starter motor and drive, the battery, a remote control starter switch (part of the ignition switch), the neutral-start switch, the starter relay, and heavy circuit wiring.

Turning of the ignition key to the START position actuates the starter relay, through the starter control circuit. The starter relay then connects the battery to the starter.

Vehicles equipped with an automatic transmission have a neutral-start switch, in the starter control circuit, which prevents operation of the starter if the selector lever is not in the N (neutral) or P (park) position.

The starter utilizes an integral positive-engagement drive (Fig. 8).

When the starter is not in use, one of the field coils is connected directly to ground through a set of contacts (Fig. 1). When the starter is first connected to the battery, a large current flows through the grounded field coil, actuating a movable pole shoe. The pole shoe is attached to the starter drive plunger lever and thus the drive is forced into engagement with the flywheel.

When the movable pole shoe is fully seated, it opens the field coil grounding contacts and the starter is then in normal operation. A holding coil is used to maintain the movable pole shoe in the fully seated position, during the time that the starter is turning the engine.

2 REMOVAL AND INSTALLATION

1. Raise the vehicle on a hoist (8-Cyl. engine only).
2. Disconnect the starter cable at the starter terminal.
3. On a Montego with power steering (8-cyl. engine) or a Mustang, Fairlane, Montego and Cougar with 428 CID engine, disconnect and lower the idler arm from the frame. Push the bolts back through the frame.
4. Remove the starter mounting bolts. Remove the starter assembly (Fig. 2).
5. Position the starter assembly to the flywheel housing, and start the

mounting bolts.

6. Snug all bolts while holding the starter squarely against its mounting surface and fully inserted into the pilot hole. Torque the bolts to specification.
7. Connect the starter cable.
8. Install the idler arm bracket (if removed), and lower the vehicle.

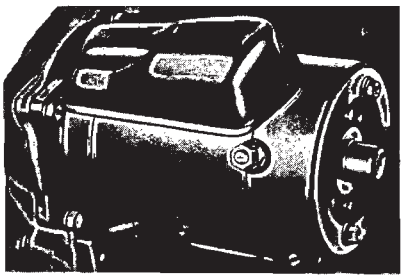

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FIG. 2—Starter Mounting

3 POSITIVE ENGAGEMENT STARTER TESTING

ROAD SERVICE

On road service calls, connect a booster battery to the system for cases of a starter that will not crank the engine or a starter that cranks the engine very slowly. If the starter does not turn the engine over, even with the booster battery attached, refer to the following tests. **Be certain that correct battery polarity is observed when using a booster battery; positive to positive, and negative to negative connection of the auxiliary cables.**

ON VEHICLE TESTING

STARTER DRIVE AND STARTER TEST

Flood the engine by pumping the accelerator eight to ten times. Turn the ignition key to start and hold it in the start position. The engine should fire immediately, but should not start and run. The starter should continue to crank the engine. This indicates a normal acceptable starter drive. If the engine stops turning and the starter spins at high speed, the drive is not operating properly and should be replaced. Whenever possible, remove the plunger cover and observe the plunger pole operation on the vehicle. **Do not damage the exposed switch during starter installation or removal.**

Temporarily connect a heavy jumper from the battery positive terminal to the starter terminal. If the starter will not crank the engine, the starter is not operating properly. Repair or replace the starter.

STARTER CRANKING CIRCUIT TEST

Excessive resistance in the starter circuit can be determined from the results of this test. Make the test connections as shown in Fig. 3. Crank the engine with the ignition OFF. This is accomplished by disconnecting and grounding the high tension lead from the ignition coil and by connecting a jumper from the battery terminal of the starter relay to the S terminal of the relay.

The voltage drop in the circuit will be indicated by the voltmeter (0 to 2 volt range). Maximum allowable voltage drop should be:

1. With the voltmeter negative lead connected to the starter terminal and the positive lead connected to the battery positive terminal (Fig. 3, connection (1).... 0.5 volt.
2. With the voltmeter negative lead connected to the battery terminal of the starter relay and the positive lead connected to the positive terminal of the battery (Fig. 3, connection (2).... 0.1 volt.
3. With the voltmeter negative lead connected to the starter terminal of the starter relay and the positive lead connected to the positive terminal of the battery (Fig. 3, connection (3).....0.3 volt.
4. With the voltmeter negative lead connected to the negative terminal of the battery and the positive lead connected to the engine ground (Fig. 3, connection (4).... 0.1 volt.

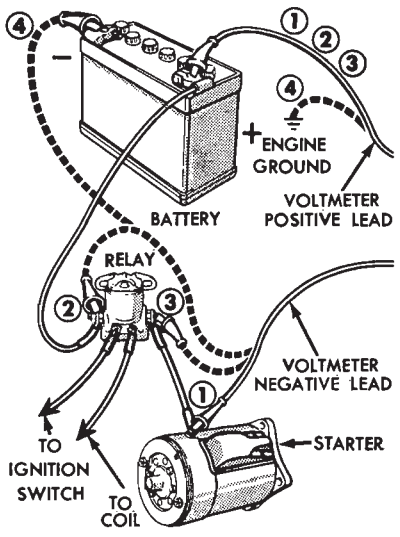

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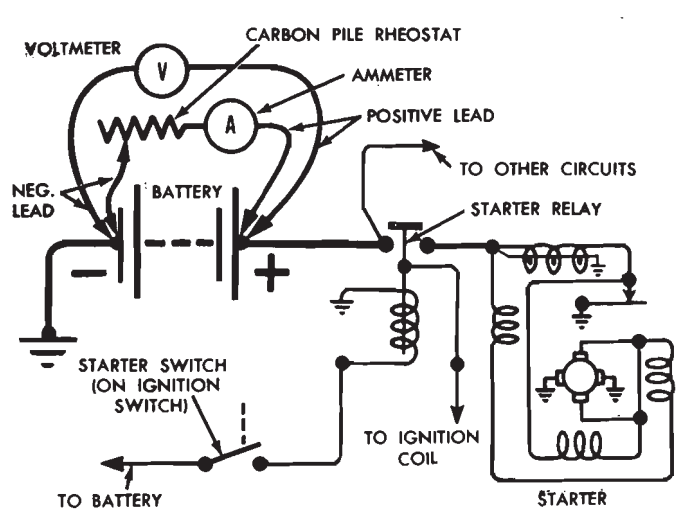
FIG. 3—Starter Cranking Circuit Test

STARTER LOAD TEST

Connect the test equipment as shown in Fig. 4. Be sure that no current is flowing through the ammeter and heavy-duty carbon pile rheostat portion of the circuit (rheostat at maximum counterclockwise position).

Crank the engine with the ignition OFF, and determine the exact reading on the voltmeter. This test is accomplished by disconnecting and grounding the high tension lead from the ignition coil, and by connecting a



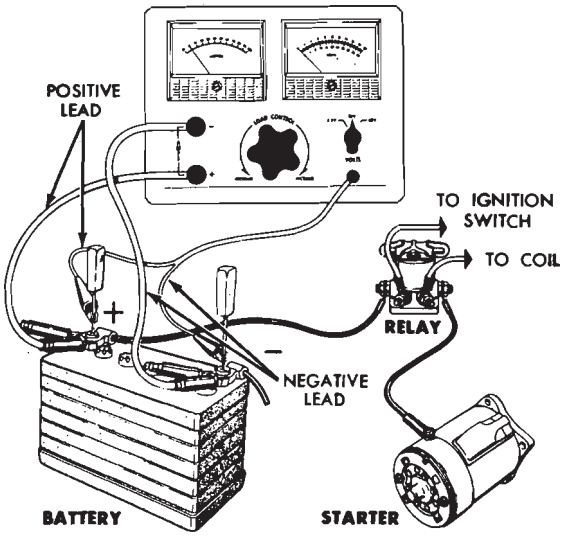


FIG. 4—Starter Load Test

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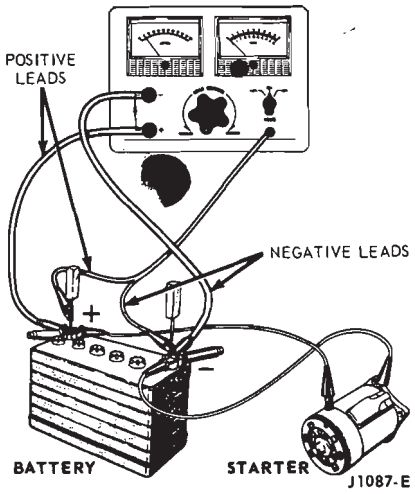

FIG. 5—Starter No-Load Test on Test Bench

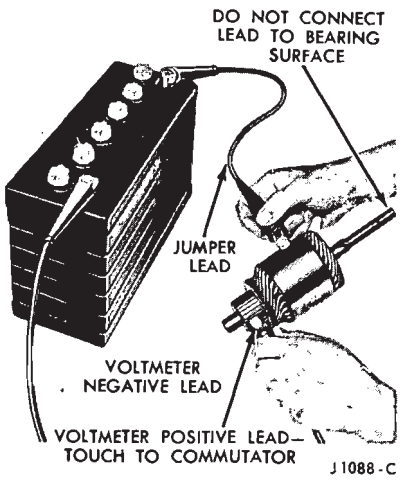

FIG. 6—Armature Grounded Circuit Test

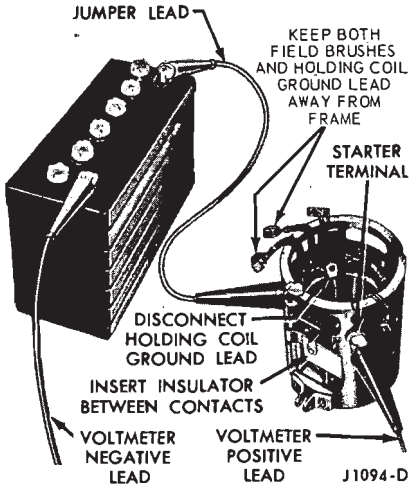

FIG. 7—Field Grounded Circuit Test

jumper from the battery terminal of the starter relay to the ignition switch terminal of the relay.

Stop cranking the engine, and reduce the resistance of the carbon pile until the voltmeter indicates the same reading as that obtained while tthe starter cranked the engine. The ammeter will indicate the starter current draw under load.

BENCH TESTS

STARTER NO-LOAD TEST

The starter no-load test will uncover such faults as open or shorted windings, rubbing armature, and bent armature shaft. The starter can be tested, at no-load, on the test bench only.

Make the test connections as shown in Fig. 5. The starter will run at no-load. Be sure that no current is flowing through the ammeter (rheostat at maximum counterclockwise position). Determine the exact reading on the voltmeter.

Disconnect the starter from the battery, and reduce the resistance of the rheostat until the voltmeter indicates the same reading as that obtained while the starter was running. The ammeter will indicate the starter noload current draw.

ARMATURE OPEN CIRCUIT TEST—ON TEST BENCH

An open circuit armature may sometimes be detected by examining the commutator for evidence of burning. A spot burned on the commutator is caused by an arc formed every time the commutator segment, connected to the open circuit winding, passes under a brush.

ARMATURE AND FIELD GROUNDED CIRCUIT TEST—ON TEST BENCH

This test will determine if the winding insulation has failed, permitting a conductor to touch the frame or armature core.

To determine if the armature windings are grounded, make the connections as shown in Fig. 6. If the voltmeter indicates any voltage, the windings are grounded.

Grounded field windings can be detected by making the connections as shown in Fig. 7. If the voltmeter indicates any voltage, the field windings are grounded.

4 POSITIVE ENGAGEMENT STARTER OVERHAUL

Use the following procedure when it becomes necessary to completely overhaul the starter. Fig. 8 illustrates a partially disassembled starter.

DISASSEMBLY

1. Loosen the brush cover band retaining screw and remove the brush cover band and the starter drive plunger lever cover. Observe the lead positions for assembly and then remove the commutator brushes from the brush holders.
2. Remove the through bolts, starter drive end housing, and the starter drive plunger lever return spring. If the starter has needle bearings, and the bearing is not being replaced, insert a dummy shaft in the housing to prevent loss of any of the bearing needles. Before assembly, apply a small amount of grease to the needles.
3. Remove the pivot pin retaining the starter gear plunger lever and remove the lever and the armature.
4. Remove the stop ring retainer. Remove and discard the stop ring retaining the starter drive gear to the end of the armature shaft, and remove the starter drive gear assembly.
5. Remove the brush end plate.
6. Remove the two screws retaining the ground brushes to the frame.
7. On the field coil that operates the starter drive gear actuating lever, bend the tab up on the field coil retaining sleeve and remove the sleeve.
8. Remove the three coil retaining screws, using tool 10044-A and an arbor press (Fig. 9). The arbor press prevents the wrench from slipping out of the screw. Unsolder the field coil leads from the terminal screw, and remove the pole shoes and coils from the frame. Use a 300-watt iron.
9. Cut (or unsolder) the insulated brush leads from the field coils, as close to the field connection point as possible.
10. Remove the starter terminal nut, washer, insulator and terminal

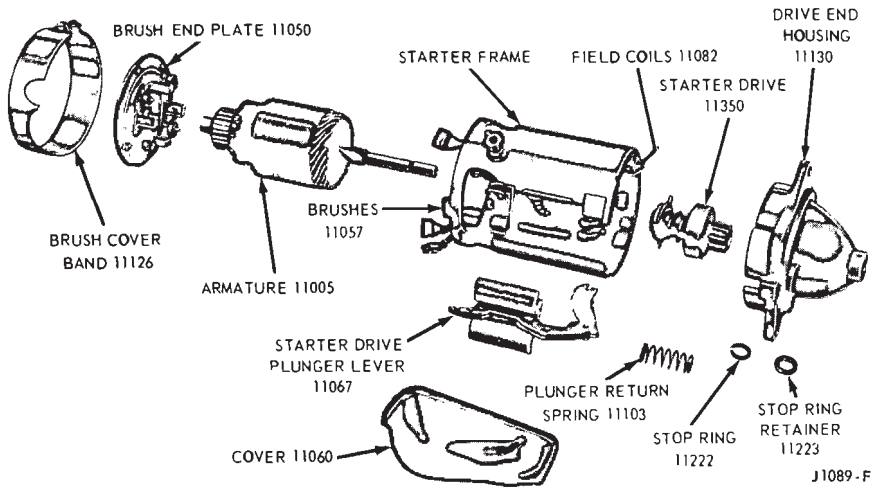

FIG. 8—Starter Disassembled

from the starter frame. Remove any excess solder from the terminal slot.

CLEANING AND INSPECTION

1. Use a brush or air to clean the field coils, armature, commutator, armmature shaft, brush end plate, and drive end housing. Wash all other parts in solvent and dry the parts.
2. Inspect the armature windings for broken or burned insulation and unsoldered connections.
3. Check the armature for open circuits and grounds.
4. Check the commutator for runout (Fig. 10). Inspect the armature shaft and the two bearings for scoring and excessive wear. On a starter with needle bearings apply a small amount of grease to the needles. If the commutator is rough, or more than 0.005 inch out-of-round, turn it down.
5. Check the brush holders for broken springs and the insulated brush holders for shorts to ground. Tighten any rivets that may be loose. Replace the brushes if worn to 1/4 inch in length.
6. Check the brush spring tension. Replace the springs if the tension is not within specified limits (40 ounces

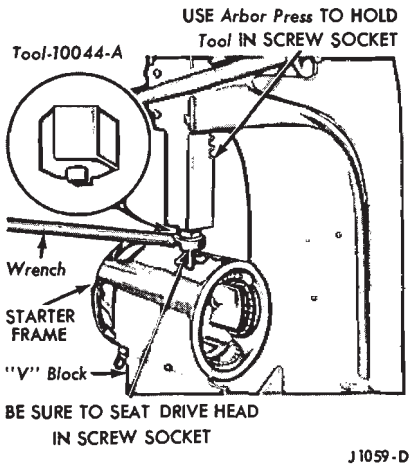

FIG. 9—Pole Shoe Screw Removal

minimum).

7. Inspect the field coils for burned or broken insulation and continuity. Check the field brush connections and lead insulation. A brush kit and a contact kit are available. All other assemblies are to be replaced rather than repaired.
8. Examine the wear pattern on the starter drive teeth. The pinion teeth

must penetrate to a depth greater than 1/2 the ring gear tooth depth (Fig. 11), to eliminate premature ring gear and starter drive failure.

9. Replace starter drives and ring gears with milled, pitted or broken teeth or that show evidence of inadequate engagement (Fig. 11).

ASSEMBLY

1. Install the starter terminal, insulator, washers, and retaining nut in the frame (Fig. 12). Be sure to position the slot in the screw perpendicular to the frame end surface.

2. Position the coils and pole pieces, with the coil leads in the terminal screw slot, and then install the retaining screws (Fig. 9). As the pole shoe screws are tightened, strike the frame several sharp blows with a soft-faced hammer to seat and align the pole shoes, then stake the screws.

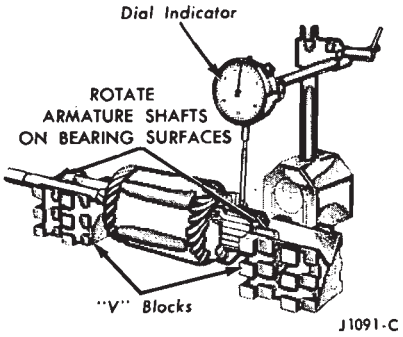

FIG. 10—Commutator Runout Check

3. Install the solenoid coil and retainer and bend the tabs to retain the coils to the frame.

4. Solder the field coils and solenoid wire to the starter terminal using rosin core solder. Use a 300-watt iron.

5. Check for continuity and grounds in the assembled coils.

6. Position the new insulated field brushes lead on the field coil terminal. Install the clip provided with the brushes to hold the brush lead to the terminal. Solder the lead, clip, and terminal together, using rosin core solder (Fig. 12). Use a 300-watt iron.

7. Position the solenoid coil ground terminal over the nearest ground screw hole.

8. Position the ground brushes to the starter frame and install the retaining screws (Fig. 12).

9. Position the starter brush end plate to the frame with the end plate boss in the frame slot.

10. Apply a thin coating of Lubriplate 777 on the armature shaft splines. Install the starter motor drive gear assembly to the armature shaft and install a new retaining stop ring. Install a new stop-ring retainer.

11. Position the fiber thrust washer on the commutator end of the armature shaft and position the armature in the starter frame.

12. Position the starter drive gear plunger lever to the frame and starter drive assembly, and install the pivot pin.

13. Position the starter drive plunger lever return spring and the drive end housing to the frame and install and tighten the through bolts to specification (55-75 inch pounds). **Do not pinch the brush leads between the brush plate and the frame.** Be sure that the stop ring retainer is seated properly in the drive housing.

14. Install the brushes in the brush holders. **Be sure to center the brush springs on the brushes.**

15. Position the drive gear plunger lever cover on the starter and install the brush cover band with a gasket. Tighten the band retaining screw.

16. Check the starter no-load current draw.

STARTER DRIVE REPLACEMENT

1. Loosen and remove the brush

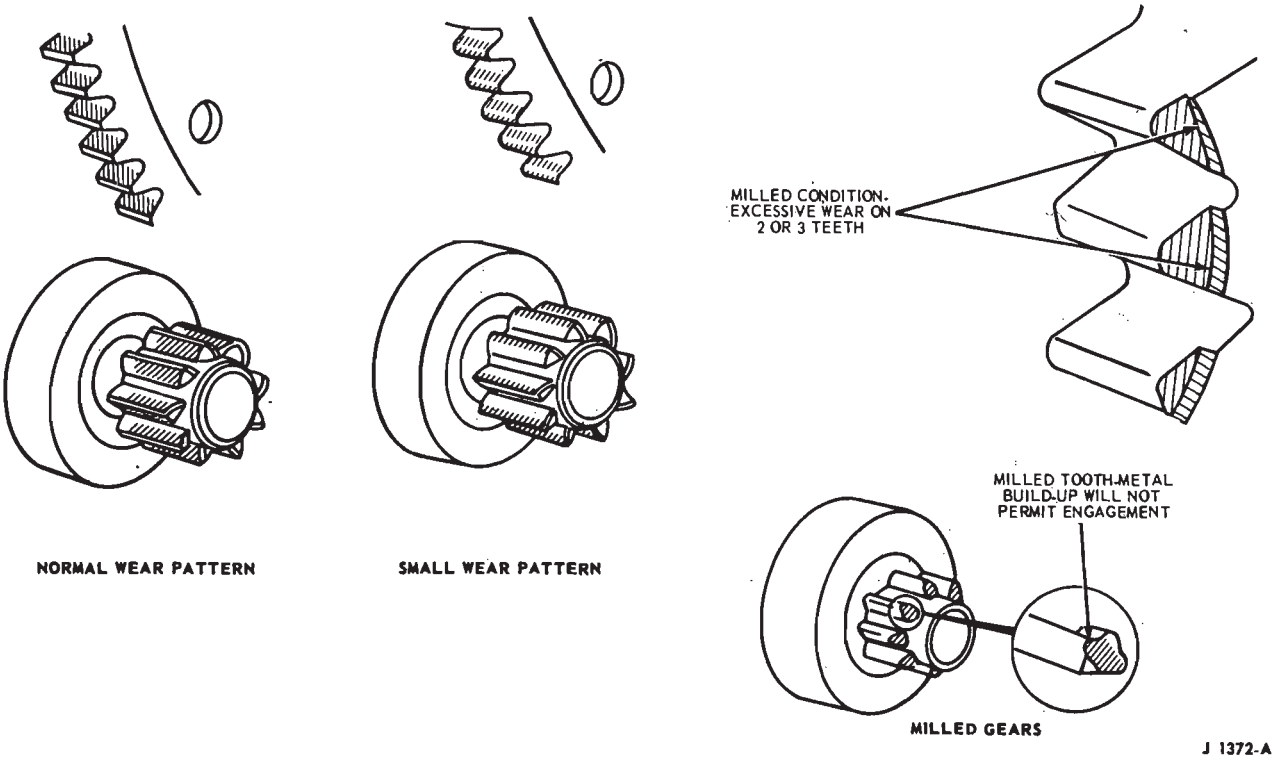

FIG. 11—Pinion and Ring Gear Wear Patterns

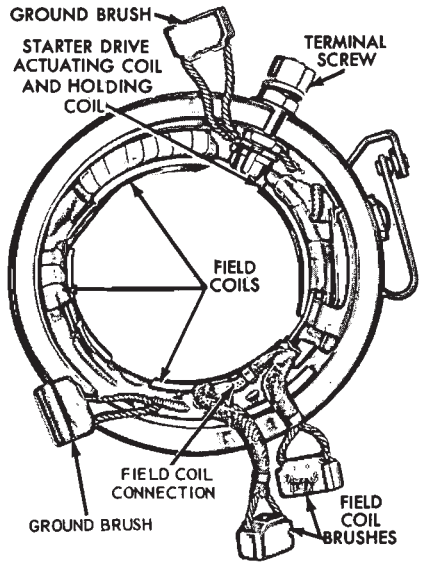

FIG. 12—Field Coil Assembly

cover band and the starter drive plunger lever cover (Fig. 8).

2. Loosen the through bolts enough to allow removal of the drive end housing and the starter drive plunger lever return spring. If the starter has a needle bearing, and the bearing is not being replaced, insert a dummy shaft in the housing to prevent loss of any of the bearing needles. Before assembly, apply a small amount of grease to the needles.

3. Remove the pivot pin retaining the starter drive plunger lever and remove the lever.

4. Remove the drive gear stop ring retainer and stop ring from the end of the armature shaft and remove the drive gear assembly.

5. Apply a thin coating of Lubriplate 777 on the armature shaft splines. Install the drive gear assembly on the armature shaft and install a new stop ring.

6. Position the starter gear plunger lever on the starter frame and install the pivot pin. **Be sure that the plunger lever properly engages the starter drive assembly.**

7. Install a new stop-ring retainer. Position the starter drive plunger lever return spring and drive end housing to the starter frame, and then tighten the through bolts to specifications (55-75 inch pounds).

8. Position the starter drive plunger lever cover and the brush cover band, with its gasket, on the starter. Tighten the brush cover band retaining screw.

BRUSH REPLACEMENT

Replace the starter brushes when they are worn to 1/4 inch. Always install a complete set of new brushes.

1. Loosen and remove the brush cover band, gasket, and starter drive plunger lever cover. Remove the brushes from their holders.

2. Remove the two through bolts from the starter frame.

3. Remove the drive end housing, and the plunger lever return spring. If the starter has a needle bearing, and the bearing is not being replaced, insert a dummy shaft in the housing to prevent loss of any of the bearing needles. Before assembly, apply a small amount of grease to the needles.

4. Remove the starter drive plunger lever pivot pin and lever, and remove the armature.

5. Remove the brush end plate.

6. Remove the ground brush retaining screws from the frame and remove the brushes (cut the ground brush nearest the starter terminal from the brush terminal block, as close to the brush lead terminal as possible).

7. Cut the insulated brush leads from the field coils, as close to the field connection point as possible.

8. Clean and inspect the starter motor.

9. Replace the brush end plate if the insulator between the field brush holder and the end plate is cracked or broken.

10. Position the new insulated field brushes lead on the field coil connection. Position and crimp the clip provided with the brushes to hold the brush lead to the connection. Solder the lead, clip, and connection together, using rosin core solder (Fig. 12). Use a 300-watt iron.

11. Install the ground brush leads to the frame with the retaining screws. The ground brush with the over-size unthreaded hole is placed under the terminal from which the previous ground brush was cut.

12. Clean the commutator with 00 or 000 sandpaper.

13. Position the brush end plate to the starter frame, with the end plate boss in the frame slot.

14. Position the fiber washer on the commutator end of the armature shaft and install the armature in the starter frame.

15. Install the starter drive gear plunger lever to the frame and starter drive assembly, and install the pivot pin.

16. Position the return spring on the plunger lever, and the drive end housing to the starter frame. Install the through bolts and tighten to specified torque (55-75 inch pounds). Be sure that the stop ring retainer is seated properly in the drive end housing.

17. Install the commutator brushes in the brush holders. Center the brush springs on the brushes.

18. Position the plunger lever cover and the brush cover band, with its gasket, on the starter. Tighten the band retaining screw.

19. Connect the starter to a battery to check its operation.

ARMATURE REPLACEMENT

1. Loosen the brush cover band retaining screw and remove the brush cover band, gasket, and the starter drive plunger lever cover. Remove the brushes from their holders.

2. Remove the through bolts, the drive end housing, and the drive plunger lever return spring. If the starter has a needle bearing, and the bearing is not being replaced, insert a dummy shaft in the housing to prevent loss of any of the bearing needles. Before assembly, apply a small amount of grease to the needles.

3. Remove the pivot pin retaining the starter gear plunger lever, and remove the lever.

4. Remove the armature. If the starter drive gear assembly is being reused, remove the stop ring retainer and the stop ring from the end of the armature shaft, and remove the drive.

5. Place the drive gear assembly on the new armature with a new stop ring.

6. Install the fiber thrust washer on the commutator end of the armature shaft and install the armature.

7. Position the drive gear plunger lever to the frame and drive gear assembly and install the pivot pin.

8. Position the drive plunger lever return spring, the drive end housing and the front end plate to the starter frame, and then install and tighten the through bolts to specification. Be sure that the stop ring retainer is seated properly in the drive housing. If the starter has needle bearings, apply a small amount of grease to the needles before installing the drive housing.

9. Place the brushes in their holders, and center the brush springs on

the brushes.

10. Position the plunger lever cover and the brush cover band, with its gasket, and then tighten the retaining screw.

11. Connect the starter to a battery to check its operation.

STARTER TERMINAL

REMOVAL

1. Loosen the brush cover band retaining screw and remove the brush cover band and the starter drive plunger lever cover. Observe the lead positions for assembly and then remove the commutator brushes from the brush holders.

2. Remove the through bolts, starter drive end housing, starter drive plunger lever return spring, and the brush end plate.

3. Remove the pivot pin retaining the starter gear plunger lever and remove the lever and the armature assembly.

4. Unsolder the field coil and solenoid wire leads from the terminal screw. Use a 300-watt soldering iron.

Remove the starter terminal nut, washer, insulator and terminal from the starter frame.

INSTALLATION

1. Install the new starter terminal, insulator, washers, uand etaining nut in the frame (Fig. 8). Be sure to position the slot in the screw perpendicular to the frame end surface.

2. Solder the field coils and solenoid wire to the starter terminal using rosin core solder. Use a 300-watt iron.

3. Check for continuity and grounds in the assembled coils.

4. Position the starter brush end plate to the frame with the end plate boss in the frame slot.

5. Position the fiber thrust washer on the commutator end of the armature shaft and position the armature in the starter frame.

6. Position the starter drive gear plunger lever to the frame and starter drive assembly, and install the pivot pin.

7. Position the starter drive plunger lever return spring and the drive end housing to the frame and install and tighten the through bolts to specification (55-75 in-lbs). **Do not pinch the brush leads between the brush plate and the frame.** Be sure that the stop ring retainer is seated properly in the drive housing.

8. Install the brushes in the brush holders. **Be sure to center the brush springs on the brushes.**

9. Position the drive gear plunger lever cover on the starter and install the brush cover band with a gasket. Tighten the band retaining screw.

10. Check the starter no-load current draw.

5 SPECIFICATIONS

POSITIVE ENGAGEMENT STARTER MOTOR						Starter Brushes				Mounting Bolt Torque (Ft.-lbs.)
Dia (Inches)	Current Draw Under Normal Load (Amps)	Normal Engine Cranking Speed (rpm)	Min Stall Torque @5 Volts (Ft-Lbs)	Max Load (Amps)	No Load (Amps)	Mfg Length (Inches)	Wear Limit (Inches)	Spring Tension (Ounces)	Through Bolt Torque (In-Lbs)	3/8-In Bolt Two-Hole Mfg
4	150-200	180-250	9.0	460	70	0.50	0.25	40	55-75	15-20
4 1/2	150-200	150-250	15.5	670	70	0.50	0.25	40	55-75	15-20
Maximum Commutator runout is 0.005 inch. Maximum starting circuit voltage drop (battery positive terminal to starter terminal) at normal engine temperature is 0.5 volt.										

CJ1430-A

SPECIAL TOOLS		
Ford Tool No.	Former No.	Description
TOOL 10044-A	10044-A	Generator Pole Screw Wrench

CJ1451-A

26-03-01

PART 26-03 *Autolite Solenoid Actuated Starters*

A page number indicates that the item is for the vehicles listed at the head of the column.

1 DESCRIPTION AND OPERATION

Major assembly components of the Autolite solenoid actuated starter are: Frame and field coil assembly, armature assembly, brush plate assembly, drive assembly, shift lever assembly, drive housing assembly and starter solenoid assembly (Fig. 1).

The motor is a four brush, four-field, four-pole wound unit.

The starter frame encloses a wound armature which is supported at the drive end with caged needle bearings and at the commutator end with a sintered copper bearing.

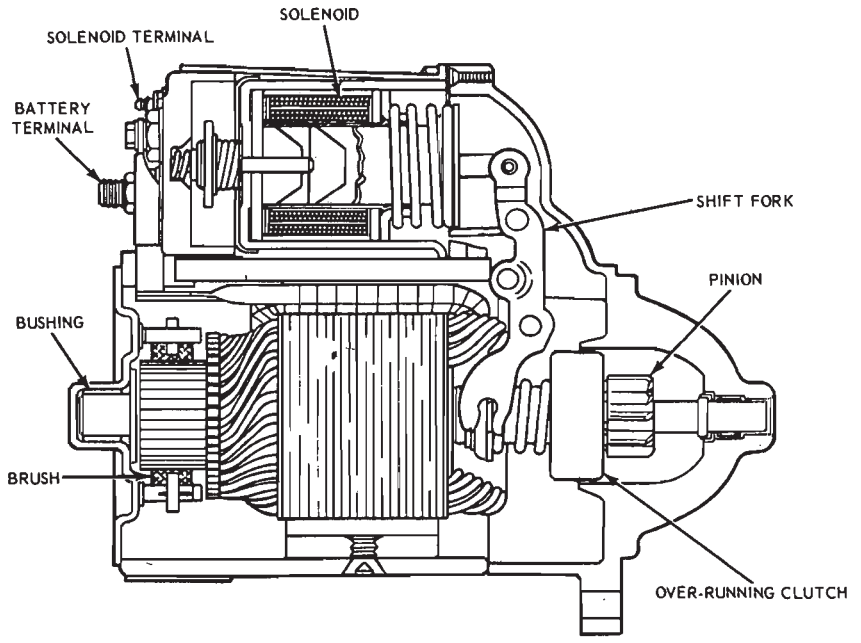

FIG. 1—Starter—Cross Section

The armature rotates between four pole shoes around which are four ribbon-wound field coils. The field coils are retained by the pole shoes which are attached to the starter frame with one pole-shoe screw each. The four field coils are connected in a series parallel circuit (Fig. 2). A rubber grommet assembled in the starter frame insulates the starter field-to-solenoid-connecting-strap, and also prevents dirt, water and oil from entering the starter.

SOLENOID

The solenoid assembly is mounted to a flange on the starter drive housing. The entire shift lever mechanism and the solenoid plunger are enclosed in the drive housing, thus protecting them from exposure to dirt and road splash.

The solenoid incorporates two windings, a pull-in winding and a hold-in winding. Together they provide sufficient magnetic attraction to pull the solenoid plunger into the solenoid.

STARTING SYSTEM OPERATION

Engine cranking occurs when the starter solenoid on the starter is energized through the starter control (ignition) switch. When energized, the

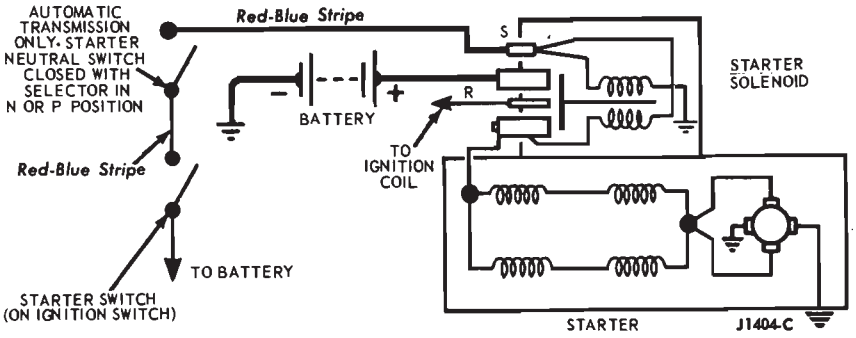

FIG. 2—Starting Circuit

solenoid shifts the starting motor pinion into mesh with the engine flywheel ring gear.

Simultaneously, the main contacts of the solenoid are closed and battery current is directed to the starting motor causing the armature to rotate.

After the engine starts, the starter drive is disengaged when the ignition switch is returned from the start to the on or run position. This opens the circuit to the starter solenoid and the solenoid return spring causes the shift lever to disengage the starter drive from the engine flywheel ring gear.

The starting motor is protected from excessive speed by an overrunning clutch incorporated in the starter drive assembly. The overrunning clutch permits the drive to rotate faster then the armature thus disengaging itself from the engine flywheel ring gear when the engine starts.

2 REMOVAL AND INSTALLATION

REMOVAL

1. Disconnect the battery ground cable, and raise the vehicle on a hoist.
2. Disconnect the cable and wires at the terminals on the solenoid.
3. Turn the front wheels fully to the right. Remove the two bolts attaching the steering idler arm to the frame.
4. Remove the starter mounting bolts and remove the starter assembly.

INSTALLATION

1. Position the starter assembly to the starter mounting plate and start the mounting bolts.
2. Snug the starting motor mounting bolts while holding the starter squarely against the mounting surface and fully inserted into the pilot hole. Torque the mounting bolts to 15-20 ft-lbs.
3. Connect the cable and wires to the terminals on the solenoid (Fig. 3). Tighten the battery cable nut to 45-95 in-lbs torque.
4. Install the steering idler arm bracket to the car frame. Torque the bolts to 28-35 ft-lbs, lower the vehicle, and connect the battery ground cable.

3 SOLENOID ACTUATED STARTER TESTING

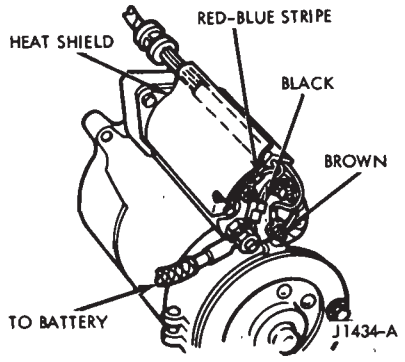

FIG. 3—Starter Cable Connections

ROAD SERVICE

On road service calls, connect a booster battery to the system for cases of a starter that will not crank the engine or a starter that cranks the engine very slowly. If the starter does not turn the engine over, even with the booster battery attached, refer to the following tests. **Be certain that correct battery polarity is observed when using a booster battery; positive to positive, and negative to negative connection of the auxiliary cables.**

ON VEHICLE TESTING

STARTER CRANKING CIRCUIT TEST

These tests will determine whether or not there is excessive resistance in the cranking circuit. Make each test connection as shown in Fig. 4. While cranking the engine, observe the voltage drop reading for each test. **Disconnect and ground the high tension lead from the ignition coil to prevent the engine from starting.** Connect a remote control switch between the battery terminal of the starter relay and the S terminal of the relay.

The voltage drop in the circuit will be indicated by the voltmeter (0 to 2 volt range). Maximum allowable voltage drop should be:

1. With the voltmeter negative lead connected to the starter terminal and the positive lead connected to the battery positive terminal (Fig. 4, connection No. 1) 0.5 volt.
2. With the voltmeter negative lead connected to the starter terminal and the positive lead connected to the battery terminal of the starter solenoid (Fig. 4, connection No. 2) 0.3 volt.

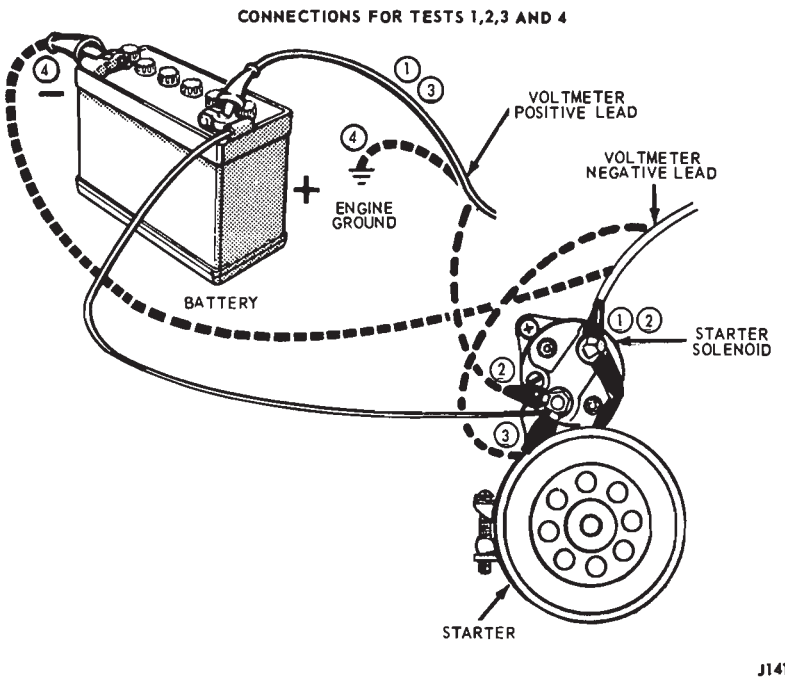

FIG. 4—Starter Cranking Circuit Test

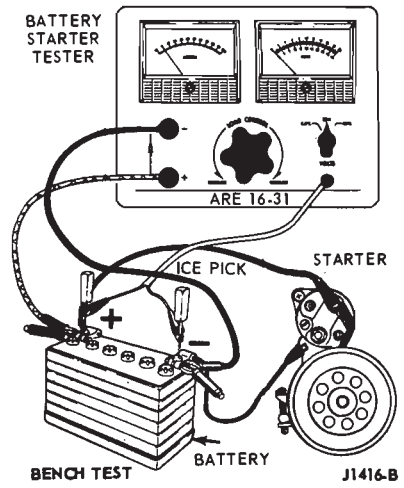

FIG. 6—Starter No-Load Test on Test Bench

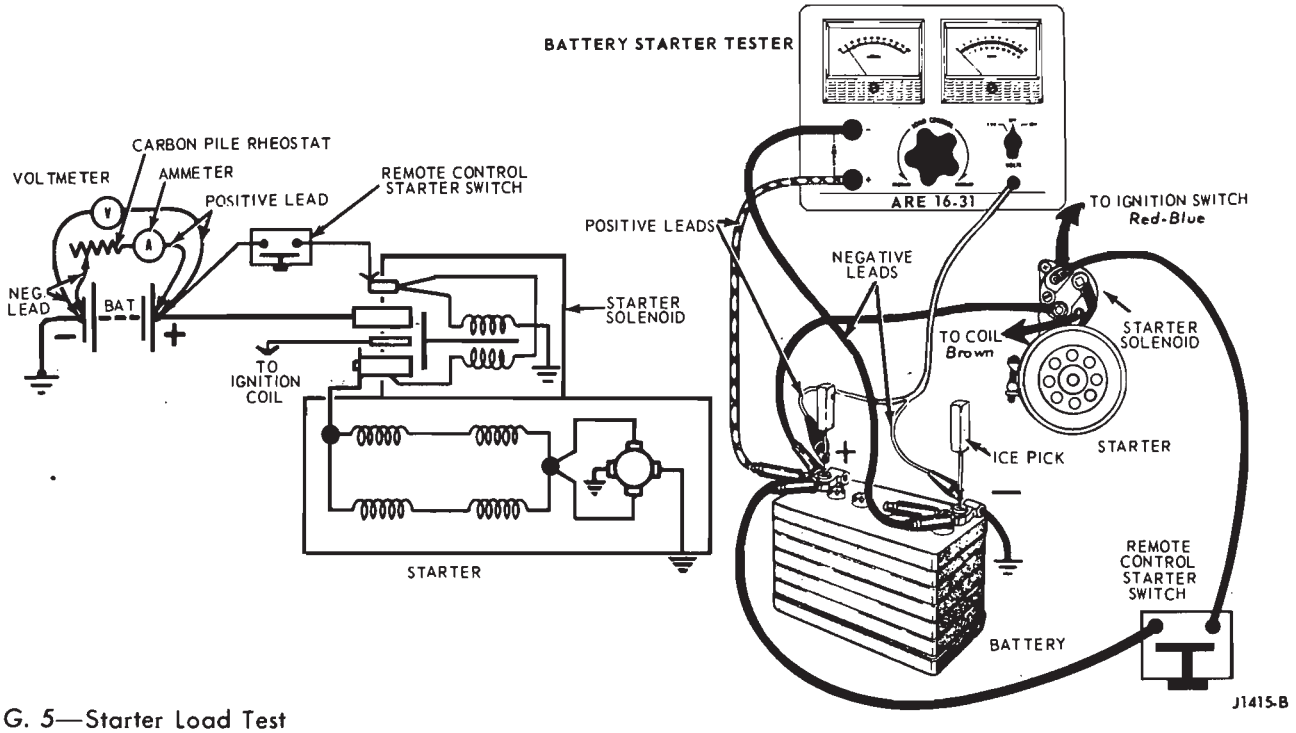

FIG. 5—Starter Load Test

3. With the voltmeter negative lead connected to the battery terminal of the starter solenoid and the positive lead connected to the positive terminal of the battery (Fig. 4, connection No. 3) 0.2 volt.

4. With the voltmeter negative lead connected to the negative terminal of the battery and the positive lead connected to the engine ground (Fig. 4, connection No. 4) 0.1 volt.

STARTER LOAD TEST

Connect the test equipment as shown in Fig. 5. Be sure that no current is flowing through the ammeter and heavy-duty carbon pile rheostat portion of the circuit (rheostat at maximum counterclockwise position).

Crank the engine with the ignition OFF, and determine the exact reading on the voltmeter. This test is accomplished by disconnecting and grounding the high tension lead from the ignition coil, and by connecting a jumper from the battery terminal of the starter solenoid to the ignition switch S terminal of the solenoid.

Stop cranking the engine, and reduce the resistance of the carbon pile until the voltmeter indicates the same reading as that obtained while the

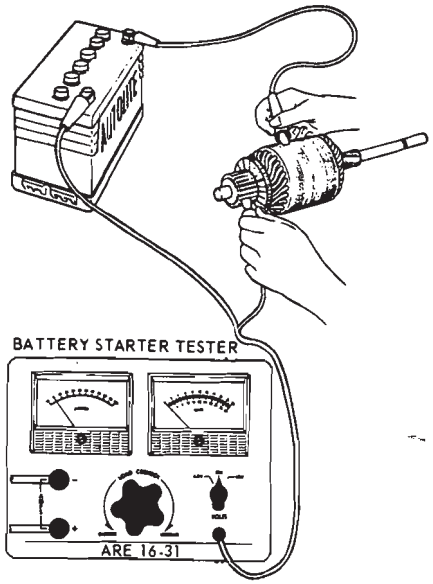

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FIG. 7—Armature Grounded Circuit Test

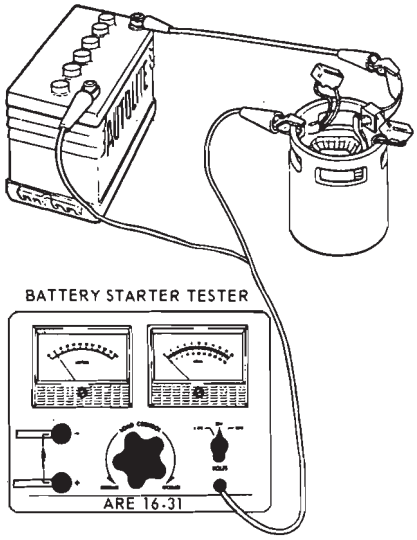

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FIG. 8—Field Grounded Circuit Test

starter cranked the engine. The ammeter will indicate the starter current draw under load.

STARTER SOLENOID TEST

If the solenoid does not pull in, in the Starter Load Test, measure the voltage between the starter-mounted solenoid switch S terminal and ground with the ignition switch closed. If the voltage is 10 or more volts a worn or damaged solenoid is indicated. Remove the starter assembly for solenoid replacement.

BENCH TESTS

STARTER NO-LOAD TEST

The starter no-load test will uncover such faults as open or shorted windings, rubbing armature, and bent armature shaft. The starter can be tested, at no-load, on the test bench only.

Make the test connections as shown in Fig. 6. The starter will run at no-load. Be sure that no current is flowing through the ammeter (rheostat at maximum counterclockwise position). Determine the exact reading on the voltmeter.

Disconnect the starter from the battery, and reduce the resistance of the rheostat until the voltmeter indicates the same reading as that obtained while the starter was running. The ammeter will indicate the starter no-load current draw.

ARMATURE OPEN CIRCUIT TEST

An open circuit armature may sometimes be detected by examining the commutator for evidence of burning. A spot burned on the commutator is caused by an arc formed every time the commutator segment, connected to the open circuit winding, passes under a brush.

ARMATURE AND FIELD GROUNDED CIRCUIT TEST

This test will determine if the winding insulation has failed, permitting a conductor to touch the frame or armature core.

To determine if the armature windings are grounded, make the connections as shown in Fig. 7. If the voltmeter indicates any voltage, the windings are grounded.

Grounded field windings can be detected by making the connections as shown in Fig. 8. If the volt-meter indicates any voltage, the field windings are grounded.

4 SOLENOID ACTUATED STARTER OVERHAUL

DISASSEMBLY

1. Disconnect the copper strap from the starter terminal on the solenoid, remove the retaining screws and remove the solenoid from the drive housing (Fig. 9).
2. Loosen the retaining screw and slide the brush cover band back on the starter frame for access to the brushes.
3. Remove the commutator brushes from their holders. Hold each spring away from the brush with a hook, while sliding the brush out of the holder.
4. Remove the through-bolts and separate the drive-end housing, starter frame and brush end plate assemblies.
5. Remove the solenoid plunger and shift fork assembly. If either the plunger or fork is to be replaced they can be separated by removing the roll pin.
6. Remove the armature and drive assembly from the frame. Remove the drive stop ring and slide the drive assembly off the armature shaft. Remove the fiber thrust washer from the commutator end of the shaft.
7. Remove the drive stop ring retainer from the drive housing.

CLEANING AND INSPECTION

1. **Do not wash the drive because the solvent will wash out the lubricant, causing the drive to slip.** Use a brush or compressed air to clean the drive, field coils, armature, commutator, armature shaft front end plate, and rear end housing. Wash all other parts in solvent and dry the parts.
2. Inspect the armature windings for broken or burned insulation and unsoldered connections.
3. Check the armature for open circuits and grounds.

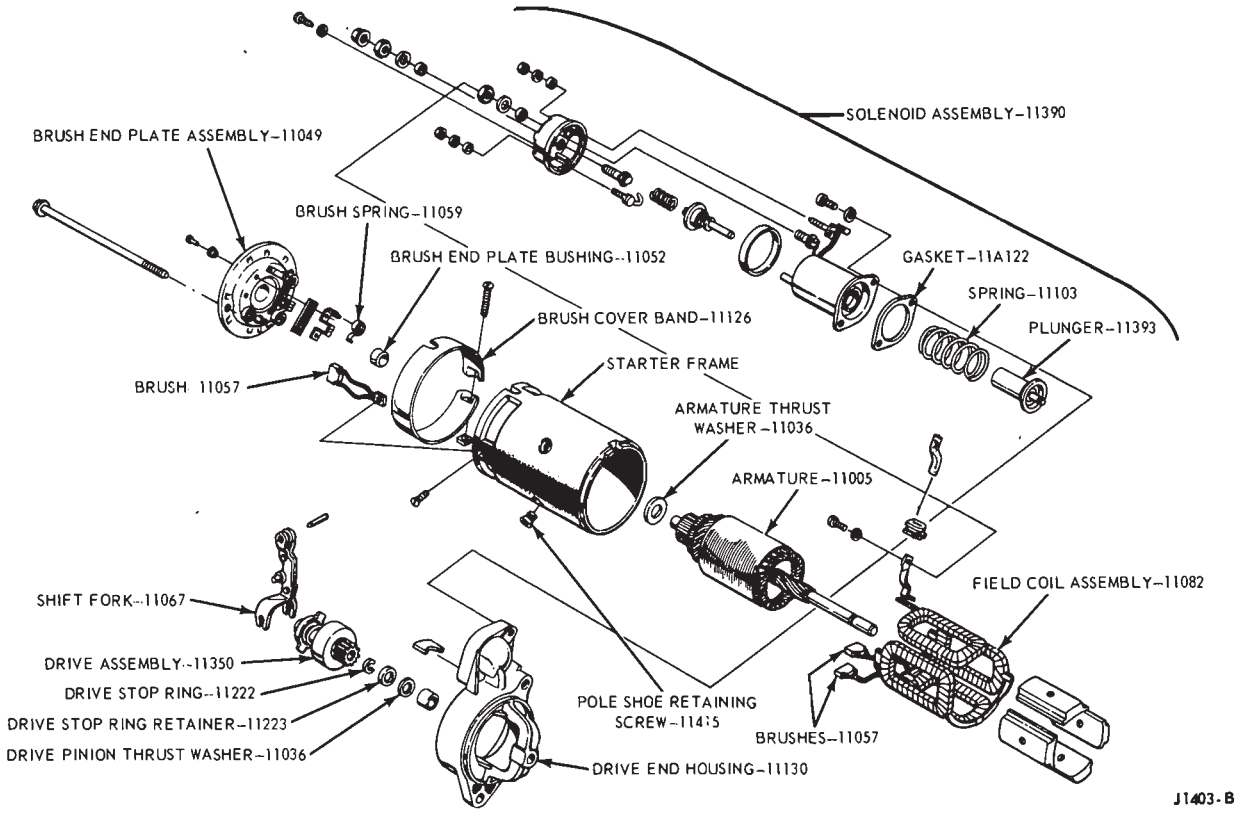

FIG. 9—Starter Disassembled

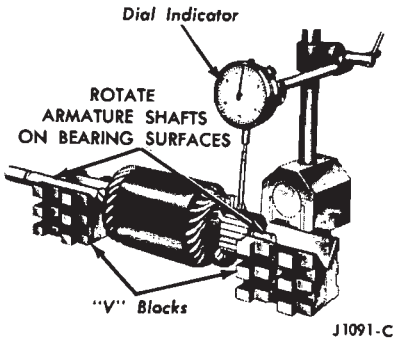

FIG. 10—Commutator Runout Check

4. Check the commutator for runout (Fig. 10).Inspect the armature shaft and the two bearings for scoring and excessive wear. On a starter with needle bearings apply a small amount of grease to the needles. If the commutator is rough, or more than 0.005 inch out-of-round, turn it down.

5. Check the brush holders for broken springs and the insulated brush holders for shorts to ground. Tighten any rivets that may be loose. Replace the brushes if worn of 1/4 inch in length.

6. Check the brush spring tension. Replace the springs if the tension is not within specified limits (40 ounces minimum).

7. Inspect the field coils for burned or broken insulation and continuity. Check the field brush connections and lead insulation. A brush kit is available. All other assemblies are to be replaced rather than repaired.

8. Examine the wear pattern on the starter drive teeth. The pinion teeth must penetrate to a depth greater than 1/2 the ring gear tooth depth (Fig. 11), to eliminate premature ring gear and starter drive failure.

9. Replace starter drives and ring gears with milled, pitted or broken teeth or that show evidence of inadequate engagement (Fig. 11).

ASSEMBLY

1. Install a small amount of lubriplate on the armature shaft splines. Install the drive assembly on the armature shaft and install a new stop ring (Fig. 9).

2. Apply a small amount of lubriplate on the shift lever pivot pin. Position the solenoid plunger and shift lever assembly in the drive housing.

3. Place a new retainer in the drive housing. Apply a small amount of lubriplate to the drive end of the armature shaft. Place the armature and drive assembly into the drive housing. Be sure that the shift lever tangs properly engage the drive assembly.

4. Place the fiber washer on the commutator end of the armature and apply a small amount of lubriplate on the shaft.

5. Position the frame and field assembly to the drive housing. Be sure that the frame is properly indexed to the drive housing assembly.

6. Position the brush plate assembly to the frame assembly. Be sure that the brush plate is properly indexed to the frame. Install the thru bolts and tighten to 45-85 in-lbs.

7. Place the brushes in their holders. Pull each spring away from the holder with a hook to allow entry of the brush. Center the brush springs on the brushes. Press the insulated brush leads away from all other interior components to prevent possible shorts.

8. Position the rubber gasket between the solenoid mounting and the upper outside surface of the frame. Position the starter solenoid with metal gasket and spring, position the heat shield (if used), and install the solenoid mounting screws.

9. Connect the copper strap to the starter terminal on the solenoid.

10. Position the cover band and tighten the retaining screw.

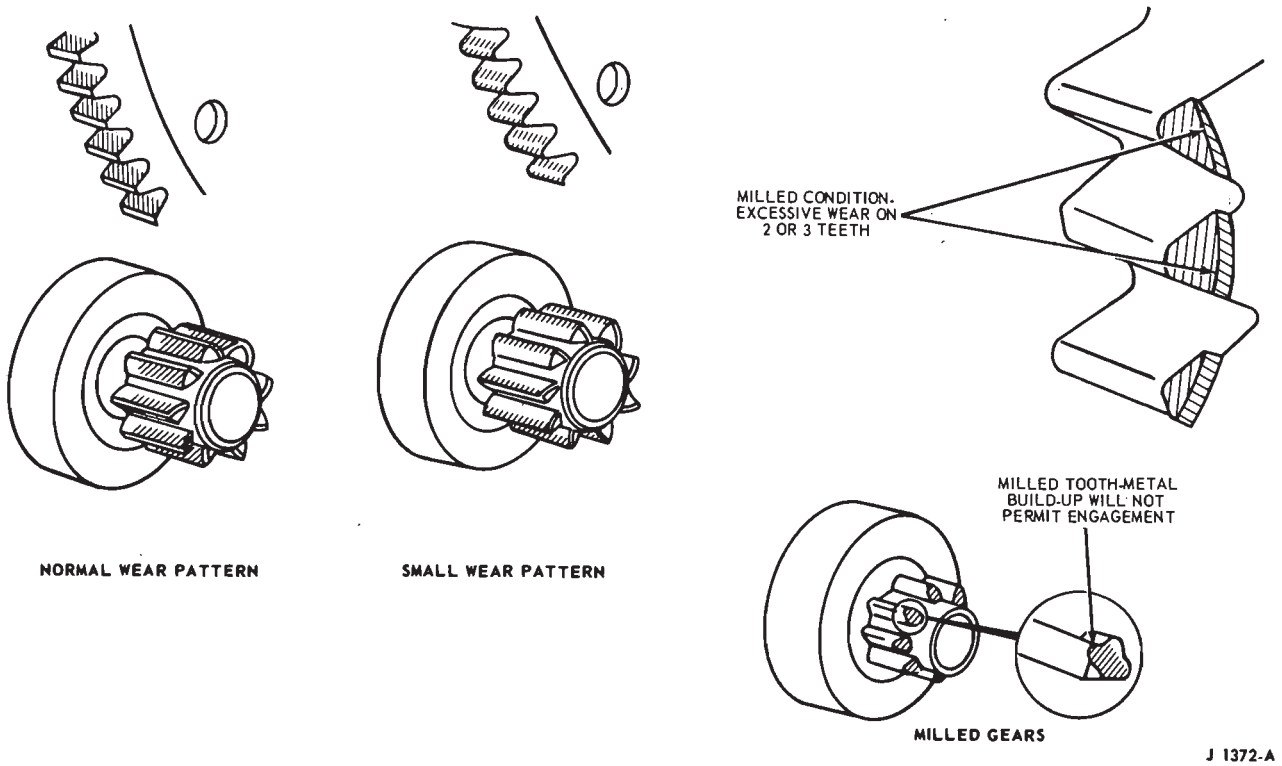

FIG. 11—Pinion and Ring Gear Wear Patterns

11. Connect the starter to a battery to check its operation.

BRUSH REPLACEMENT

Replace the starter brushes when they are worn to 1/4 inch. Always install a complete set of new brushes.

1. Disconnect the copper strap from the starter terminal on the solenoid.

2. Loosen the retaining screw and slide the brush cover band back on the starter frame for access to the brushes.

3. Remove the commutator brushes from their holders. Hold each spring away from the brush with a hook, while sliding the brush out of the holder.

4. Remove the through-bolts and separate the drive end housing, starter frame and brush end plate assemblies.

5. Remove the ground brush retaining screws from the frame and remove the brushes.

6. Cut the insulated brush leads from the field coils, as close to the field connection point as possible.

7. Clean and inspect the starter motor.

8. Replace the brush end plate if the insulator between the field brush holder and the end plate is cracked or broken.

9. Position the new insulated field brushes lead on the field coil connection. Position and crimp the clip provided with the brushes to hold the brush lead to the connection. Solder the lead, clip, and connection together, using rosin core solder. Use a 300-watt iron.

10. Install the ground brush leads to the frame with the retaining screws.

11. Clean the commutator with 00 or 000 sandpaper.

12. Place the fiber washer on the commutator end of the armature and apply a small amount of lubriplate on the shaft.

13. Position the rubber gasket over the solenoid plunger lever, then position the frame to the end housing so that the wide slot in the frame clears the plunger lever and the end housing dowel is indexed with its frame slot.

14. Position the brush plate assembly to the frame assembly. Be sure that the brush plate is properly indexed to the frame. Install the thru bolts, making certain that the insulated brush lead is not between the through bolt and the frame, and tighten to 45-85 in-lbs.

15. Place the brushes in their holders. Pull each spring away from the holder with a hook to allow entry of the brush. Center the brush springs on the brushes. Press the insulated brush leads away from all other interior components to prevent possible shorts.

16. Slide the cover band into position and tighten the retaining screw.

17. Connect the copper strap to the starter terminal on the solenoid.

18. Connect the starter to a battery to check its operation.

5 SPECIFICATIONS

SOLENOID ACTUATED STARTER MOTOR					Starter Brushes		Bolt Torque (Ft-Lbs)	
Dia. (Inches)	Current Draw Under Normal Load (Amps)	Normal Engine Cranking Speed (rpm) @70° F.	No Load (Amps)	Mfg Length (Inches)	Wear Limit (Inches)	Spring Tension (Ounces)	Through Bolt Torque (In-Lbs)	5/16 in. Bolt Three Hole Mtg.
4-1/2	180-210	140-170	70	0.50	0.25	40	45-85	15-20
Maximum Commutator runout is 0.005 inch. Maximum starting circuit voltage drop (battery positive terminal to starter terminal) at normal engine temperature is 0.5 volt.								

CJ1452-A

SPECIAL TOOLS		
Ford Tool No.	Former No.	Description
TOOL 10044-A	10044-A	Generator Pole Screw Wrench

CJ1453-A